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Potato diseases and their remedies
L. R. Jones & W. J. Morse.

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Director's office, chemical, horticultural and veterinary laboratories are at the Experiment Station building, at the head of Main street; botanical and entomological laboratories are at Williams Science Hall, University place.

Experiment farm and buildings are on the Williston road, adjoining the University grounds on the east.

BULLETIN 106. ABSTRACT OF ANNUAL REPORT 1902-03

By J. L. Hills

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INTRODUCTION

It has been the policy of this Station for some years past to make its report the repository of technical scientific matter and its bulletins the vehicle for conveying more popular information. This rule has often been disregarded. The reports have contained articles of but little scientific value, while some bulletins have been eminently technical. Still the distinction has been a fairly close one. The scientific discussions must needs be published, since the determination and dissemination of such matters, by the terms of the National enactment governing the Station and its operations, are its main function, popular ideas to the contrary notwithstanding. These technical data, however, are apt to make dry reading, and the Station reports are doubtless considered by many to be heavy documents. It has on this account seemed desirable to depart from the former custom, to print only a limited edition of the full report, and to prepare for the general reader a popular resumé, containing the essentials without entering into the details. Such a summary is presented in this bulletin. Any reader who wishes the unabridged report, a volume of about 200 pages, may obtain it without charge by asking for it.

This bulletin contains statements concerning plant diseases, potato maladies and their prevention, weeds (particularly the dangerous shrubby cinquefoil, of Bennington county), apple tree borers, mushrooms, fertilizer analyses, and dairy husbandry, including feeding trials, herd records, etc. The matter having to do with plant diseases and weeds is abstracted from the report of the botanists, L. R. Jones and W. J. Morse; the borer article is briefed from the horticulturist's report by William Stuart; the statements as to mushrooms, infant foods and fertilizers are from the pen of the chemist, C. H. Jones; while the dairy husbandry matter was the work of the writer.

The composite nature of the bulletin makes a table of contents more than ordinarily necessary, and it appears herewith.

PLANT DISEASES IN VERMONT IN 1903

WEATHER CONDITIONS

The summer of 1903 was an unusual one. From the middle of April to the first week of June there was no rainfall. This was followed by unusually copious rains and cool, cloudy weather during July and August. The effect of the weather conditions as regards pathological conditions of plants was shown in various ways. Most insect pests were less troublesome than usual. Many forms of fungi which make their chief headway in the spring, such as apple scab, were also less troublesome than usual. On the other hand, certain physiological diseases were unusually prevalent as a result of the abnormal weather conditions.

POTATO BLIGHTS

Few potatoes made much growth until the rains came in June. They then developed rapidly. Less arsenical poisoning than usual was noted because less of paris green and similar insecticides were used. The late development of the plants, coupled with the climatic conditions, led to little tip burn. The early blight did little damage up to late August, except on light sandy soils. On such it was serious by August first. The late blight fungus was also tardy in appearing, being fully three weeks later than last year. The first blighting leaves were found about August 10, 1903. The malady spread gradually during August.

Early sprayings with insecticides or fungicides alike profited less than usual. This outcome is in marked contrast with that of last year, when an unusually early application was needed. This will doubtless tend to discourage some who, through lack of experience, sprayed too late in 1902 and too early in 1903. It emphasizes again the importance of learning to recognize the maladies to be controlled. A single thorough spraying given at the right time was a sufficient protection.

ORCHARD DISEASES

There was practically no loss from apple and pear scab even on the more susceptible varieties, such as Fameuse apples and Flemish beauty pears.

The weather conditions caused some russeting of the skin of apples. This was more evident on the sprayed than on the unsprayed fruit, although occurring on the latter. Frost bands were conspicuous upon apples in many parts of the state. Such russeting, whether a re-

sult of climatic conditions or of spraying, injures neither the keeping quality nor the flavor of the fruit.

The bacterial disease pear blight was also less prevalent than usual on pears, and no twig blight was observed on plum trees. The brown rot of plums also caused but little destruction.

GARDEN VEGETABLES

A soft rot of turnip developed badly in the station garden, club rot of cabbage, turnips, etc., was reported from certain localities, and onion mildew was again destructive.

POTATO DISEASES AND THEIR REMEDIES

I. THE RESULTS FROM SPRAYING POTATOES IN 1903

1. GAINS FROM USE OF BORDEAUX MIXTURE

Experimental sprayings of potatoes with fungicides and other compounds have been conducted at this Station each summer for fourteen years. During this time a large number of preparations have been tested and nothing equal to bordeaux-arsenical mixture has been found for use in the latter part of the season. The gains from the right use of this mixture have been large on the average and are chiefly attributable to the prolongation of the life of the foliage into the autumn, through protecting it from both fungus and insect ravages. In general two applications of the mixture have proved most profitable. Owing, however, to the late appearance of the blight in 1903, and the fact that its development was checked by continuous dry weather in early September, a single application of the mixture, about the tenth of August, proved sufficient for the preservation of most of the foliage from blight. On heavy soil there was some rot where the plants were sprayed only once, but the crop in the main field of the station farm, which was a sandy loam, three and one-half acres in extent, thus sprayed once, retained its foliage in good shape well through September and yielded over 1200 bushels of marketable potatoes with practically no rot.

No unsprayed rows were left in this field, but in a smaller one on higher but somewhat heavier soil, records were obtained. This field was planted with the Green Mountain variety about May first, and given one thorough application of bordeaux mixture on August 10. The plots were dug Sept. 24. The unsprayed tops had been dead for some two weeks, while at least fifty percent of the foliage was still alive on the sprayed tops. The sprayed and unsprayed portions were carefully selected with a view to uniformity. Each lot consisted of

four rows fifty-eight feet long. The total yields calculated in bushels to the acre are as follows: Sprayed, 392 bushels per acre; unsprayed, 285 bushels per acre; an increase in total yield as a result of spraying of 107 bushels.

This gain was not as large as it has been in seasons when the blight has come earlier and progressed more rapidly. On the other hand under such conditions two or even three sprayings are required to preserve the foliage until the maturing of the crop. The *gain of 124 bushels per acre as the result of a single timely spraying* represents a larger gain in proportion to the cost than we have heretofore recorded. We learned of cases where potato growers sprayed their plants twice this season *in July* and secured but little benefit for the simple reason that by the time the blight was destructive, the latter half of August, their plants were unprotected. Our experience again serves to emphasize sharply the point we have repeatedly made, that *in order to spray most profitably a man must know what he is spraying for, watch his crop and spray intelligently as well as thoroughly.* To paraphrase the old saying, a spray in time saves the crop. *Timeliness* is an important factor in success. That is pays richly to use *thoughtfulness, thoroughness* and *timeliness* may be judged from the cumulative data showing the results from thirteen consecutive season's work at this Station. These figures speak for themselves.

GAINS FROM USE OF BORDEAUX MIXTURE ON LATE POTATOES.

Variety	Planted	Sprayed	Yield per acre		Gain per acre
			Where sprayed	Whe'e not sprayed	
White Star...	May 11, 1891.	Aug. 26, Sept. 8.....	313 bu.	248 bu.	65 bu.
" " ...	May 20, 1892.	July 30, Aug. 18, 25.....	291 bu.	99 bu.	192 bu.
" " ...	May 20, 1893.	Aug. 1, 16, 29.....	338 bu.	114 bu.	224 bu.
" " ...	Apr. 26, 1894.	June 16, July 17, Aug. 30	328 bu.	251 bu.	77 bu.
" " ...	May 20, 1895.	July 25, Aug. 13, 31.....	389 bu.	219 bu.	170 bu.
Polaris.....	May 15, 1896.	Aug. 7, 21.....	325 bu.	257 bu.	68 bu.
"	June 1, 1897.	July 27, Aug. 17, 28.....	151 bu.	80 bu.	71 bu.
White Star...	May 10, 1898.	July 21, Aug. 10.....	238 bu.	112 bu.	126 bu.
Average 3 var.	May 18, 1899.	July 26, Aug. 17, Sept. 8	229 bu.	161 bu.	68 bu.
Delaware	May 23, 1900.	Aug. 4, 23	285 bu.	225 bu.	60 bu.
"	May 25, 1901.	July 20, Aug. 21.....	170 bu.	54 bu.	116 bu.
"	May 15, 1902.	Aug. 1, 20.....	298 bu.	164 bu.	134 bu.
Green Mount.	May 1, 1903.	Aug. 10.....	361 bu.	237 bu.	124 bu.
Averages for thirteen years.....			286 bu.	171 bu.	115 bu.

2. ADDITIONS OF BUG DEATH AND PARIS GREEN TO BORDEAUX MIXTURE

This experiment was conducted in a field belonging to the Mary Fletcher hospital. Its object was to determine the relative efficiencies of bug death and paris green when used alone and with bordeaux mixture in the latter part of the season.

The plots were dug on October 7th (two months after spraying), when the tops on all the rows were entirely dead, with an occasional exception where bordeaux mixture had been used. The following gives the treatment and the yield from each treatment (three rows), in pounds:

Treatment.	Yield, 3 rows.
Paris green	220 pounds.
Control (untreated)	241 "
Bordeaux-paris green mixture	278 "
Bordeaux-bug death mixture	280 "
Bug death applied dry	237 "

The conclusions warranted by the results thus far discussed seem to be as follows:

(1) Neither paris green nor bug death used alone have value in checking the late blight, even where, in the case of bug death, very liberal application is made.

(2) So far as controlling late blight is concerned, bordeaux-bug death mixture and bordeaux-paris green mixture are both efficacious, the one as good as the other, and doubtless simple bordeaux mixture without any insecticide added would prove as good as either.

To avoid being misunderstood, we will repeat what we have stated in previous years, that it is outside of the plans of these experiments to inquire closely into the insecticidal value of bug death. We have, however, seen evidence that it has such value in trials of former years. This year in the absence of insects this factor did not enter into the results.

II. RELATION OF DATE OF DIGGING TO DEVELOPMENT OF ROT

"How soon after the tops begin to die from the late blight should the potatoes be dug?" This question is of much practical importance and we undertook in 1902 to secure an answer. Although the results obtained in those trials appeared definite and justified a tentative deduction, it was felt that conditions might so vary from year to year that further trials were needed. Accordingly on August 31, twenty rows of potatoes, forty-five feet long, were staked off on a field belonging to the Mary Fletcher hospital. These were on rather low ground in slightly moist and somewhat sandy soil. The late blight was abundant over the entire field, although it had mostly developed within the preceding week. On the plot selected one-third to one-half of the foliage had been killed during this week by late blight.

Four rows were dug on each of five different dates, at intervals of one week, in such a manner as to give each time as near as possible an average of the plot.

Each lot was stored within a few hours after digging in a cool house cellar and placed in bushel boxes, stacked up so as to allow free ventilation.

When each lot was dug they were carefully sorted and the weight of decayed tubers recorded. Those in storage were sorted on each date of digging, beginning September 7 and ending September 28.

The average total weight obtained per row at each digging:

When dug	Aug. 31	Sept. 7	Sept. 14	Sept. 21	Sept. 28
Weight, pounds	50.6	54.9	55.1	54.2	50.3

Average weight of potatoes from each digging which were sound on September 28:

Date of digging	Aug. 31	Sept. 7	Sept. 14	Sept. 21	Sept. 28
Weight, pounds	22.8	40.8	46.2	47.8	46.6

Average decay per row previous to September 28:

Date of digging	Aug. 31	Sept. 7	Sept. 14	Sept. 21	Sept. 28
Pounds decayed	28.0	14.1	8.7	6.2	3.7
Percent decayed	55.3	25.7	15.8	11.4	7.3

There is very little difference in the results from those dug Sept. 14, 21 and 28, while the digging of September 7 gave about eight-ninths as much, and that of August 31 less than one-half that obtained from the three later dates. The death of a large percent of the foliage occurred between August 31 and September 7, and the entire tops were dead on September 14. Hence the data obtained this year appear to confirm the rule laid down in the former report: "*That where there is danger of rot it is best to delay the digging some ten days or more after the tops die and that a longer delay does no harm.*"[1]

III. DOES LIMING PREVENT ROT?

Many farmers recommend sprinkling potatoes with air slaked lime when placed in the cellar. This treatment it is claimed reduces the amount of decay in stored tubers. In order to test the efficacy of this treatment, one-half of the yield of each row used in the trial last described (except those dug on September 28), was sprinkled at the rate of about a quarter of a pound of lime to the bushel and placed side by side with the unlimed portion. The nature of the soil, dates of digging and sorting, and condition of foliage at each digging, have already been described.

The following statement combines the results of all the four plots used in the experiment:

Total decay of limed potatoes to September 28.....	91.3
Total decay of untreated potatoes to September 28.....	85.8
Total of limed potatoes sound, September 28	311.9
Total of untrated potatoes sound, September 28	317.4
Percent of decay in limed	29
Percent of decay in untreated	27

DISCUSSION OF RESULTS

So far as can be judged from the results of this single experiment there is nothing to be gained by liming, there being but two percent difference and that in favor of the untreated tubers.

This trial of one season with only a few bushels of potatoes should not be regarded as conclusive. It does, however, lead us to doubt the value of the practice; yet the writer would be glad to learn of the experience of any potato growers with liming potatoes, where definite gains were demonstrated.

IV. POTATO SCAB EXPERIMENTS

Experiments in the disinfection of seed potatoes for scab were carried out during the season of 1903, along the lines suggested by the results of previous years. Two grades of seed were planted, "scabby" and "smooth."

The washed seed potatoes were divided into five lots; one was soaked for two hours in formalin solution, 8 ounces in 15 gallons of water; another was soaked for one and one-half hours in corrosive sublimate solution, 1 ounce in 8 gallons of water; a third lot was moistened and then submitted to the vapor of formaldehyde, a fourth was thus treated dry, while a fifth lot was left entirely untreated.

As in all previous trials, extending now through several years, corrosive sublimate and formalin proved equally efficient. They afford a cheap and eminently satisfactory means whereby the small potato grower may combat scab. For the large grower and the seed dealer who handles hundreds of bushels, a less laborious process is to be desired. It would be so much more economical and satisfactory in such cases to use a gaseous disinfectant that we have for several years been testing various methods looking to this end.

Formaldehyde gas is a most promising candidate for favor. Only one percent of the crop raised from seed thus treated was scabby.

We are not yet fully satisfied that this dry fumigation process is equal to the disinfection attained by soaking the seed potatoes in formalin or in corrosive sublimate solution. These processes have been proved reliable by long experience, whereas this fumigation

method should still be considered as in the experimental stage. In view of the several years' results, however, and especially of those of the last summer, dealers and large growers who do not consider the soaking process practicable under their conditions, are advised to use the fumigation process providing their storage room will permit it.

NOTES ON CERTAIN THREATENING WEEDS

The Station considers that one of its duties is to watch for the appearance and spread of weeds new to the State. The worst pests already present in Vermont are usually foreign plants; and possibilities in the direction of these importations are far from being exhausted.

KING-DEVIL WEED. (*Hieracium praealtum*)

This plant is closely related to the orange hawkweed and is said to equal it as a pest. It is established as a bad weed in north-eastern New York, in Maine and in south-eastern New Hampshire. A specimen was brought to the Station in the summer of 1903 by Mrs. Nellie F. Flynn, gathered on the Rutland railroad track near the mouth of the Winooski river, Burlington. The plants found were promptly eradicated. It is to be hoped that it has not seeded or established itself elsewhere in that region. It is so serious a pest that farmers and railroad section men should strive to keep it out of the State. The plant closely resembles the orange hawkweed, differing chiefly in having slightly smaller flowers of a yellow color.

CREEPING SOW-THISTLE (*Sonchus arvensis*)

This is probably the hardest thistle to eradicate that occurs in grain fields. It is frequent in sections of Canada and is spreading into north-western Vermont, especially in Grand Isle county. This plant, like the king-devil weed, is apparently migrating by way of the railroads, but is probably carried in seed oats or other grain as well.

It is a conspicuous plant when in flower, having yellow dandelion-like blossoms, borne on stems, which raise them above the oats or other grain. They are open in July. Its perniciousness as a weed is due to its underground creeping root stocks, which enable it to spread under cultivation as does the Canada thistle and quack-grass. Farmers should be especially careful not to use or distribute for seed purposes oats containing seeds of this plant.

BLUE THISTLE (*Echium vulgare*)

This is an European weed occurring in New York and Canada. Until recently it was practically confined in this State to portions of Bennington and Rutland counties. It has appeared several times of

late years at scattered points along the Rutland and Central Vermont railroads, at Charlotte, Colchester, Burlington and Milton. Like the two plants just described it deserves the attention of both railroad section men and farmers.

It is worst as a weed in moist rocky pastures. It is easily recognized by its deep blue blossoms about the size of pea blossoms, and its abundant covering of prickly hairs. The latter give it a thistle-like character, whence its name, for it is not a true thistle.

RUSSIAN THISTLE (*Salsola tragus*)

This tumble weed which caused so much alarm to the farmers of the north-west some years ago, was found last year in South Hero in an abandoned quarry from which ballast had been taken for the Rutland railroad. The single plant seen had not scattered its seed and, as it was promptly destroyed, it is hoped that it is exterminated. This is cited, however, as another illustration of how the railroads serve as weed highways.

CLOVER DODDER (*Cuscuta*)

The dodders are parasitic plants which twine about clover and other plants and kill them. They resemble tangles of yellowish fibres without leaves or conspicuous blossoms. One or more species have been introduced with clover seed and were sent to us from various localities during the past summer. They should be exterminated promptly whenever seen since they may prove the worst of weed pests of meadows if allowed to become established.

THE PRICKLY LETTUCE (*Lactuca scariola*)

This plant has in recent years come to rival the ragweed as an omnipresent annual in waste places in portions of the northern Mississippi valley. It also seems destined to spread in Vermont along the railroads, since it was first seen on the railroad track at Rouses' Point and, later, in the railroad yards at St. Albans. It has also been seen in waste places in Vergennes and Rutland. It will not prove as serious an intruder as any of the plants previously described, but it is an objectionable visitor which should be kept out at least as long as it can be. It is most easily recognized by the thistle-like appearance and curious habit of its leaves, which bear along the margins and in the mid-rib numerous rather soft prickles and which are usually so twisted at the base as to stand on edge tending toward the north and south plane. It is therefore a "compass-plant," the odd position of the leaves resulting from the influence of sunlight and directing one to the points of the compass.

THE SHRUBBY CINQUEFOIL AS A WEED.

Weed problems are always in a measure local problems. Climate, soil and cultural conditions determine largely the character and prevalence of the weeds. We have seen no more striking illustration of this fact than that offered by the plant under discussion. As will be shown in detail later in this article, the shrubby cinquefoil, *Potentilla fruticosa*, is widely distributed in the north temperate zone, but, outside of a few limited areas, it is a botanical rarity. In certain sections, however, including parts of south-western Vermont, it has proved the most aggressive weed invader known to the farmers, taking almost complete possession of the pastures and pushing even into tilled lands. The Experiment station has been appealed to so frequently in regard to this plant that a systematic and fairly exhaustive study of it has been undertaken, with especial reference to its spread as a weed and its control.[1] Certain experiments are under way which will not be completed for some time, but it seems expedient to delay publication awaiting their outcome.

I. NAMES AND DESCRIPTION

The plant passes under a variety of local popular names, such as prairie-weed or prairie-bush, sage-bush, wild sage, hawley-weed, Manchester-weed, Sandgate-weed, hardhack, Goshen-hardhack, Goshen-weed, black brush and Chester-flower. Shrubby cinquefoil is the common name used by botanical writers, but it is rarely heard among practical farmers. This is, however, the best name available for general use.

GENERAL DESCRIPTION

The shrubby cinquefoil is from one to five feet high. A score of stalks radiate to form a rounded bush, often covering an area of twenty square feet or more. The bark, especially on the older stems, is shreddy. Five to seven leaflets are borne on each compound leaf. These have a grayish tint from a covering of silky hairs. From May until October the outer branches are dotted with pretty bright yellow flowers, about the size and general appearance of buttercups. These characters combine to make so pleasing a shrub that it is frequently used in ornamental plantings. The recent Cyclopedia of American Horticulture speaks of it as "a useful shrub, flowering throughout the year."

Sprig of shrubby cinquefoil

PROPAGATION AS A WEED

The plant forms a great abundance of seeds, a score or more per flower, each slightly smaller than timothy seed, enclosed in a hairy envelope (an achene) which aids in its dissemination. These remain on the plant until winter. Most of them shed between December and March and are scattered by the wind, especially when there is a crust of snow upon which to drift. There is no reason to believe that they are ever carried by stock either in the hair or wool or through the manure.

Seed (enlarged)

The plant sprouts freely from the crown if cut back, but it does not spread by underground stems or roots, that is to say, it is not stoloniferous.

II. OCCURRENCE

Habitat.—The shrubby cinquefoil is at its best in cold, moist, rocky soil, preferably, according to evidence to be cited later, of limestone formation. It is not, however, closely confined to such a habitat as is shown by its remarkable development as a weed.

Geographical distribution.—Botanists find the species in the northern part of the north temperate zone throughout both hemispheres. It reaches into the Arctic circle in places, and extends well southward in the Himalaya mountains, and to the southern limits of the United States in the Rocky mountains. It is, however, essentially a plant of the cooler soils or higher altitudes. Although so widely distributed it has shown no weedy tendency outside of certain sections of New England and New York.

IN VERMONT AT MANCHESTER AND DORSET

The conditions in these two towns will be described in some detail and this may serve as a basis for the discussion of other sections.

The worst occurrence of the plant is in the valley extending from two miles south of Manchester to Dorset village, a distance of about ten miles. It is no exaggeration to say that with rare exceptions every hillside pasture in Manchester is filled with this pest and the same is true of those of all of Dorset except in the north-west portion. A conservative estimate gives 5,000 acres as the area almost wholly occupied by this plant. This is a narrow valley of high elevation, about 1,000 feet, at the head waters of the Otter Creek and Pawlet rivers which turn north towards Lake Champlain and of the Battenkill river, the course of which is southward to the Hudson. The soil is naturally rich. The hillside pastures, where most of the cinquefoil occurs, are rocky and moist, having in most places a gravelly subsoil. It is a

limestone region with several marble quarries. The plant usually gains its first foothold in the moister situations, but it is by no means restricted to these. The tallest plants and most crowded growth occur in rich soil of a medium degree of moisture, and even the dryer summits of the rounded knolls are completely covered with its growth. It rapidly encroaches upon any field which is left unplowed for a few years, unless kept out by the closest pasturing and digging. The rapidity and completeness of its invasion may be illustrated by a specific case of a pasture of some thirty acres. Thirty years ago this was a clean pasture of the very best quality. Twenty years ago it was, generally speaking, free from this weed, but since that time the cinquefoil has rapidly increased, until to-day the field is scarcely worth fencing for pasture purposes. It is covered with an almost impenetrable matted growth from two to four feet in height, through which the cattle make their way only along narrow paths. The grass, even where the animals can reach it, is scant and spindling.

Without doubt the plant was a native of this section. Most of these fields were first cleared of forest and brought under cultivation a hundred years or more ago. During the first half of this period there seems to have been little trouble with the cinquefoil. Traditions date its first encroachments back some fifty years, and its serious development, at least in most sections, has occurred within thirty or forty years. The testimony is conclusive that it is extending its invasion into new territory in certain directions.

ELSEWHERE IN VERMONT

West and south of Manchester it is found in the adjoining towns of Sandgate and Arlington, though it is less troublesome here. Little of it occurs south of this point in Vermont until Pownal, the southern border town, is reached, when the back pastures are full of it.

North of Dorset there is little of it in the Pawlet valley, but it follows the course of the Otter Creek from the east side of the town northward through the towns of Danby, Tinmouth, Clarendon, Rutland and Pittsford, then it retreats to the hillsides on the east side of the valley where scattered areas occur in Brandon and Salisbury. The latter place, forty miles north of Manchester, marks its northern extension as a weed, and, indeed, so far as is known to us, no cultivated plants have been found, even by botanists, north of Salisbury, except in the Winooski gorge near Burlington, Smuggler's Notch of Mount Mansfield and the Lake Willoughby cliffs.

It is frequent in certain localities east of Manchester and Dorset in the valleys tributary to the Connecticut, and has been making somewhat alarming headway in recent years in sections of Stratton, Jamaica,

Windham, Wardsboro, Newfane, and other portions of the West River valley.

Specimens have been brought to us from Strafford, fifty miles further north in the Connecticut valley, but no complaints have been made of it as a weed.

OUTSIDE OF VERMONT

In western Massachusetts, especially in the south-western portion, the development of the cinquefoil as a weed is similar to that of Manchester and Dorset. O. B. Gilbert, as a result of his observations, says: "in Berkshire county, Massachusetts, it is common in nearly if not quite every town.

C. H. Peck, New York State botanist, writes us that he has seen it occupying moist pastures in Columbia county, which adjoins Massachusetts on the east.

In Litchfield county, in north-western Connecticut, it occurs much as it does in western Massachusetts. Hon. T. S. Gold, Ex-Secretary of the State Board of Agriculture, who lives in this country and knows the weed, writes that "this region was settled about 1750. The hardhack[1] lands of to-day were then the best pastures and it is within the memory of our old men that it first became a troublesome pest. It spreads rapidly and now thousands of acres in this country are infested with it."

RELATION OF ITS WEEDY DEVELOPMENT TO SOIL CONDITIONS

The native habitat of the shrubby cinquefoil is always cool, moist and usually rocky situations. Its original stations in the areas under consideration were doubtless the borders of swamps and streams and in springy places. In its present occurrence as a weed it shows a decided preference for such situations, but it is by no means confined to them. Once established its abundant crop of seeds is annually broadcasted over all adjacent fields and the plants spring up everywhere from the summit of the gravelly knoll to the rich cultivated lowland.

The remarkable development of the plant as a weed in the clearly defined area under consideration suggests some favoring conditions other than soil moisture. The infested area in New England and New York, as described, extends in a narrow belt from Salisbury, Vt., at the north, with a slight interruption in south-western Vermont, through western Massachusetts, a little of adjacent New York and well into north-western Connecticut. All along this area it has sharp delimitations on both the western and the eastern borders.

It is a noteworthy fact that the badly infested areas are without exception calcareous soils, and, in most cases, they are in the limestone belt. This relation will become clearer by comparing the distribution of the weed with the limestone formation of western New England, as shown in the accompanying map.

We do not wish to imply that this plant is confined to calcareous soils. It does seem to us probable, however, that its rapid development as a weed is to be expected in such soils, and it is to be hoped that in soils of other character it may give little if any trouble. If this is the case it may be expected gradually to extend its area of invasion in the Champlain valley in Vermont and to prove relatively less troublesome in the Connecticut valley. The plant has no known economic value.

III. METHODS OF CONTROL OR ERADICATION

PREVENTION

This weed is not likely to be introduced with seed or with manure. Its seeds are not carried long distances by the wind, at least not in great numbers. As already stated its invasion is probably wholly through seeds drifting on the snow crust in winter, and these in Vermont fields cannot go long distances. If fields are free from it, it is not difficult to keep them free, unless they are in immediate proximity to infested lands. Even then it can be done as is amply shown by certain fields in Manchester. Some farms are practically free from the plant although adjacent and similar fields are overgrown. Their occupants control it in part by cutting out occasional plants, but chiefly by *heavily stocking their pastures* with cattle, so that everything is kept closely fed to the ground. High-grade, intensive, dairy farming will, in our judgment, keep clean the fields not as yet occupied by it. One dairyman who has had long experience with it, recently said "if I had to fight hardhack over again I should do it with bran." When the pasture is too large to admit of stocking the whole of it heavily enough to keep down the weeds, it will probably prove better in the end to fence off the back portions and let them grow up to trees at once, while heavily stocking the balance and giving it sufficient care to keep it free from this and other weeds.

These statements apply to land already free or nearly free from shrubby cinquefoil. It is not so easy to say what course is best with the fields completely occupied by it. The following discussion summarizes our present judgment regarding this matter.

Burning, so it is said by Dorset farmers, if it is done for two years in succession, improves conditions. This method, however, seems to have found but little favor with farmers in the infested regions.

At best it is only temporizing with the evil. Possibly the combination of burning with the use of goats, or with reforestation, as discussed later, may prove desirable upon further trial.

Mowing may be a good practice where the plant is just coming into the pasture. Occasional mowing will not kill the plant, however, as may be seen in numerous wet meadows where the plants are mown annually with the hay.

From the middle of July to the first of September is probably the best time for mowing this as is the case with most shrubby growths. The plants may be cut off with a grub hoe just beneath the surface, thus leaving fewer stubs. A method recommended as accomplishing the same end in a more satisfactory manner is that of knocking the plants out with an axe or grub hoe when the ground is frozen.

PLOWING, GRUBBING AND PULLING

Plowing with grubbing and pulling out the larger stools is the only method fully endorsed by most practical farmers in the infested regions. The general method is to go into the field with a strong team, heavy plow and two or three men. These will clear one-fourth to three-fourths of an acre a day. To hire this crew will cost about $6.00, making the cost from $8.00 to $24.00 an acre. This, unfortunately, is more than most of the land is worth after it is cleared. Frequently such work can be done at leisure times with the regular farm help, under such circumstances the cash outlay is really less than this.

A common practice is to sow buckwheat the first year, potatoes or winter rye the year following, and then to seed down with grass. It is the testimony of those who have so cleared up cinquefoil fields that the land occupied by it is in excellent condition when reclaimed.

THE USE OF STOCK

CATTLE AND SHEEP

Cattle and sheep will browse the cinquefoil somewhat, but they refuse to make it a steady diet. Heavy stocking of the threatened pastures *which are free from* the weed, supplementing the pasture with grain as needed, will keep the weed out, but that it is practically impossible to kill out a fully established growth of it in this way.

ANGORA GOATS

This animal has been widely heralded during recent years as an aid in killing brush in pastures. It has, therefore, seemed worth while to make trial of it in connection with this particular problem. Two young ewe goats were inclosed in an area of one hundred square rods

in a corner of a pasture which was completely overgrown by this plant. They have been kept there now during two open seasons.

In July, 1903, when the last observations were made, many of the branches of the cinquefoil were dead, but a majority were continuing to send out struggling young shoots. Most of the stools were sending up some shoots from the base also. Since the goats were cropping these off promptly it seems probable that few plants in this area will survive the winter of 1903-04. Whether the goats fully exterminate the weed or not they certainly will come near to doing so. By keeping the foliage browsed from the bushes the sunlight is admitted so that the value of the grass in the area is already doubled or trebled.

REFORESTATION

General remarks.—There can be no doubt that considerable areas of so-called pasture lands in Vermont and the other New England states are destined to revert to tree growth. The sooner this growth begins upon certain classes of land the better it will be for the next generation and for the State as a whole.

In so far as pasture weeds like the orange hawkweed, brake, hardhack and shrubby cinquefoil force upon the doubting landowner the wise decision to fence off such portions of the back pastures as are practically worthless for stock grazing and permit trees to take possession, they may indeed be blessings in disguise. This will seem to many a harsh and heartless doctrine. If understood aright, it is not so. Nature is kindly, if her laws are heeded; but those laws are changeless, and he who opposes them must suffer and meet sure defeat. A more liberal fertilization and a heavier stocking of the lower and better pastures, combined with gradual relinquishment to forest growth of the poorer and less accessible ones, is the inevitable course before Vermont farmers.

Fortunately the shrubby cinquefoil is killed quickly by tree growth of any kind. If stock is fenced out of a field trees will soon come in, and the cinquefoil weaken and die out as the trees overshadow it. It will probably be more profitable thus to encourage tree growth in many infested fields than to try to reclaim them by plowing or stocking.

Wherever *white pine* trees are found to grow well, plantings will prove profitable. Judging from the results where a few young pines are growing in an infested field in Dorset, the cinquefoil will not yield to them as quickly as to some other kinds of trees.

Willows were found to check it in Connecticut.

Butternuts.—A strange thing observed in connection with shrubby cinquefoil is the apparent antagonism existing between it and the but-

ternut tree. This is a matter of common report with the farmers of Manchester and Dorset and careful observations by the writers have confirmed their idea. The cinquefoil rarely grows close to a butternut tree. This fact is strikingly shown where butternut trees occur in fields overgrown with the cinquefoil. Each large tree occupies the center of a clear grassy circle of a diameter considerably exceeding the farthest spread of its branches. The deadily influence of the butternut is made even more evident in the case of rapidly growing young trees by the fact that the base of the tree forms the center of an area of dead cinquefoil plants.

Moreover with such butternuts the "dead line" for the weed is pushed outward year by year as the tree enlarges so that the trees may be surrounded by a circle of dead and dying cinquefoil plants bordering the clean grassy plot under the tree. This antagonism is, we believe, attributable rather to the root relations of the two plants than to those of shade. Thus young butternuts from two to eight feet high were observed to be surrounded by a circle which might be twice the diameter of the top of the tree within which the weeds were dead and with dying plants bordering its margins. Such butternuts do not cast much shade. Moreover, young birch, beech, maple, cherry, apple, and pine trees in the same field showed no such striking relation to the death of the cinquefoil, healthy plants of the weed frequently crowding close under their branches.

From the practical standpoint it is evident that the butternut should be given a prominent place in any scheme of reforestation looking to the extermination of the cinquefoil. One young butternut on each square rod of infested soil would probably in ten years' time kill most, if not all, of the cinquefoil.

COMPOSITION OF MUSHROOMS

As occasion has offered during the past few years, samples of edible mushrooms found in and around Burlington have been secured, identified and analyzed. The analyses show, as has been pointed out by other observers, that mushrooms are particularly rich in water, the amount varying from nearly 89 to 95 percent. Their chief value as food is derived from the nitrogenous matter present. Many writers have overrated their value in this particular. The greatest amount of nitrogen found among the samples examined was 10.20 percent, on a dry matter basis, which when calculated to its original moisture amounts to but 0.75 percent. Forty-four percent of this nitrogen was present in the non-albuminoid form, which does not have the food

value of protein. A considerable proportion of the nitrogen in all the samples was found to be in the non-albuminoid form.

The variation in composition between samples of the same species, taken at different times and places, is quite marked and may indicate that the age of the specimen and the nature and abundance of the plant food present in the soil during the growth have an important influence.

ANALYSES OF INFANT FOODS

The following analyses of infant foods were made in the Station laboratory by Mr. C. I. Boyden. The samples were bought from local drug stores.

Peptogenic milk powder made by Fairchild Bros. & Foster, New York city, is not sold as a complete food. It is used to modify the composition of cows' milk. It is practically nothing but lactose (milk sugar).

Mellin's food, manufactured by Doliber, Goodale & Co., Boston, Mass., appears to be commercial maltose, which always contains dextrine, to which has been added some material which gives the entire goods about 10 percent of protein.

Eskey's albuminized food, manufactured by Smith, Kline & French of Philadelphia, is composed mainly of lactose and starch, with relatively small amounts of maltose and protein.

Horlick's malted milk, put up by the Horlick Food Co. of Racine, Wisconsin, contains nitrogenous material, lactose, dextrin, a small amount of starch and nearly 50 percent of maltose.

Lactated food and cereal milk are manufactured by the Wells-Richardson Co. of Burlington, Vt. The former contains some 46 percent of starch, together with lactose, maltose, sucrose and protein. The latter contains about 42 percent of maltose, a small amount of starch, nearly 28 percent of lactose, together with some 10 percent of protein.

MISCELLANEOUS ANALYSES

Section 263 of the Vermont Statutes requires the station to analyze free of charge miscellaneous materials of an agricultural nature for residents of the State. Those deemed of sufficient interest to place on permanent record are here recorded.

MATERIALS FURNISHING NITROGEN

Material	From	Percent nitrogen
Nitrate of soda,	Thetford,	15.82
Nitrate of soda,	Woodstock,	15.92
Sulphate of ammonia,	W. Brattleboro,	20.97
Dried blood,	Burlington,	11.92
Dried blood,	W. Brattleboro,	14.70
Dried blood,	Westminster West,	10.50

MATERIALS FURNISHING NITROGEN AND PHOSPHORIC ACID

Material	From	Percent of nitrogen	Percent of phosphoric acid
Rawbone meal,	Burlington,	2.63	27.56
Fine ground bone,	Burlington,	2.49	25.90
Bone meal,	Hyde Park,	2.95	18.42

The raw bone used is clearly misnamed. The goods are a steamed or extracted bone, probably substituted for the raw bone meal ordered.

MATERIALS FURNISHING AVAILABLE PHOSPHORIC ACID

Material	From	Phosphoric acid				
		Soluble %	Reverted %	Insoluble %	Total %	Available %
Acid phosphate	Burlington			3.05	17.86	14.81
Acid phosphate	W. Brattleboro			1.23	17.61	16.38
Acid phosphate	Thetford	11.92	4.68	0.95	17.55	16.60
Dissolved bone black	Burlington			18.88	2.25	16.63

MATERIALS FURNISHING POTASH

Material	From	Percent of potash
Muriate of potash,	Burlington,	52.15
Muriate of potash,	Thetford,	56.25
Muriate of potash,	Swanton,	50.85
Sulphate of potash,	W. Brattleboro,	49.85
Sulphate of potash,	Woodstock,	50.55
Kainit,	Middletown Springs,	14.00
Kainit,	W. Brattleboro,	18.00

All the samples are up to standard and one of the muriates is exceptionally rich in potash.

WOOD ASHES

From	Soluble potash %	Insoluble potash %	Total potash %	Total phosphoric acid %	Calcium oxide %	Insoluble matter %
O. N. Kittridge, Brownsville	0.38	0.97	1.35	0.79	27.96	5.02
G. O. Kelton, Rutland	6.52	0.42	6.94	2.87	31.04	13.79
A. A. Dunklee, So. Vernon	5.60	0.64	6.24	1.66	34.60	4.75
A. A. Dunklee, So. Vernon	2.70	0.74	3.44	1.40	28.05	13.56
A. A. Dunklee, So. Vernon	3.16	0.70	3.86	1.76	30.52	20.29

The first sample had evidently been leached. It carried nearly 30 percent of water when received.

The remaining samples show extensive variations in soluble potash, from 2.70 to 6.52 percent. We would suggest that purchasers of ashes submit samples to the Station for analysis before paying much money for them.

FERTILIZERS AND HOME MIXTURES

From	Nitrogen %	Soluble phosphoric acid %	Reverted phosphoric acid %	Insoluble phosphoric acid %	Total phosphoric acid %	Available ph's phoric acid %	Potash %
F. C. Nelson, W. Pawlet	2.49	2.35	5.39	2.93	10.67	7.74	8.35
F. C. Nelson, W. Pawlet	2.56				19.00		11.38
R. Bradley, Brattleboro	0.84	7.88	3.32	2.07	13.27	11.20	5.40
R. Bradley, Brattleboro	2.24	6.26	3.39	2.37	12.02	9.65	4.05
J. B. Candon, Pittsford	2.80	6.42	4.23	3.02	13.67	10.65	2.20
Ira G. Miller, Westminster W.	6.25	1.15	3.76	1.37	6.28	5.13	12.68
A. K. Ellsworth, N. Cambridge	1.05				0.21		0.63

The second sample from West Pawlet was a mixture of ground bone and muriate of potash. The last sample was the dried residue left after washing sheep. It carried 1.43 percent water, 69 percent ash and 29.57 percent of organic and volatile matter.

For particulars regarding home mixing and fertilizers in general, the reader is referred to bulletins 93 and 99, which will be sent free of charge on request.

Samples of maple syrup and maple sugar sent from Danville and Barre, respectively, were examined with results as follows:

	Maple syrup	*Maple sugar*
Sucrose	54.84	88.38
Reducing sugars	10.17	0.60
Ash	0.15	0.18
Water	33.25	{ 15.84
Undetermined	1.59	

The syrup was very dark colored and probably adulterated with cane sugar. The maple sugar was very light colored and extremely hard. Its low ash content leads us to believe that it was adulterated with liberal amounts of cane sugar.

APPLE TREE BORERS

Borers are serious pests throughout the apple farming sections. An unusual opportunity having arisen for observations upon the round-headed type, the writer deems it worth while to make some brief statements as to their nature and the means of combating them, even though, strictly speaking, it lies outside of the particular province of his line of work.

The injurious effects of the round-headed apple tree borer were very apparent in the orchards examined. In one, which consisted entirely of trees under ten years of age, a large percent of them were seriously injured and many killed outright. Others were so nearly dead that after blooming they failed to put forth leaves. Any tree in which a borer passes its larval life is much the worse for it; and, when, as sometimes happens, eight or ten make a tree their abiding place, its usefulness is past.

LIFE HISTORY

The eggs are laid in slits in the green bark of the trunk of the tree, at or near the surface of the ground. They may be deposited as high as 18 inches, but usually are found near the base. They are probably deposited in this latitude from the middle of June to the latter part of August. The egg soon hatches and the young larva begins at once to gnaw its way through the inner bark and cambium layer. On the approach of winter it tunnels its way down the trunk of the tree below the surface of the ground. With the advent of spring it ascends and passes the summer in the sap wood. The second winter is passed in a similar manner to that of the first. The third season the larva again ascends and bores or gnaws its way into the heart wood of the tree, and in all directions. Towards the close of the season it gnaws its way upward and outward to the bark of the tree, after which it withdraws into its burrow, encases itself with the castings of wood and soon enters into the pupal stage of its ex-

istence. Early in the next June it cuts its way out, emerges as a mature beetle, the female deposits its eggs and the life cycle is completed.

PREVENTIVE MEASURES

The sundry measures recommended looking towards prevention are of two classes. They looked either to the exclusion or the repulsion of the insect. It is either shut away or turned away from the tree trunk.

Exclusion.—This method of combatting the borers seems to the writer to be the more hopeful if the work is carefully done. Various materials may be used for wrapping the trunk, such as heavy wrapping paper, manila paper, tar paper or fine wire screen. Their efficacy is entirely dependent on the care and skill with which they are put on. To be effective they must fit sufficiently close to the trunk and come up high enough to prevent the beetle from depositing its eggs. The material used in fastening the wrappers should be such as is easily broken by the growth expansion of the tree. The employment of tar paper or fine wire netting serves the double purpose of excluding insects and protecting the trunks from injury by mice, rabbits or other small rodents. One objection sometimes urged against wrapping the tree trunk with heavy paper, is that, upon its removal, it renders the tree more subject to sun scald. Another, which might be raised, is that unless examined occasionally, the wrapper is apt to get disarranged and instead of being a protection it may serve as a screen for the insects.

Repulsion.—The application to the tree trunk of some caustic or ill-smelling compound serves to repel the borer in proportion to the thoroughness with which it is used and the persistency of the retention. Most of the washes employed are of an alkaline nature, consisting of soaps, or lyes, caustic in their action, to which, frequently, enough carbolic acid is added to give an offensive odor. Quite recently painting the tree trunks with pure white lead and linseed oil has been highly recommended by Alwood of the Virginia station, as being an effective repellant of the round-headed apple-tree borer. The ease of application and the persistency of the material should warrant its trial on a small scale in this latitude. Various patent washes have been from time to time widely advertised. Most of these compounds contain coal-tar products, which, while ill-smelling enough, are more or less injurious to the trees. Such are not, as a rule, to be recommended. It is evident that the protection of the trunk by washes can be effective only when it is kept covered with it.

Remedies.—After the larva has entered the tree, there is practically but one thing to do. It must be dug out. A strong bladed knife and a rather strong, flexible wire are the only tools required. It is usually stated that it is sufficient to go over the trees twice yearly, in May and September. The writer recommends that, in badly infested orchards, at least, a further inspection be made in July. Many of the newly laid eggs could then be destroyed. The presence of the young larva in the tree is usually easily detected, since they lie near the surface and generally cause a slight flow of sap from the wounded tissue. The bark, moreover, is usually somewhat discolored. They are easily reached at this stage of their development, and, if destroyed, cause but little injury to the tree. As they grow older they advance deeper into the wood and their presence can only be detected by the fresh castings that are pushed out as they gnaw through the wood tissues. The knife is used to remove the castings which clog the tunnel and then the flexible wire is inserted. If the course of the larva is not too devious, one can generally succeed in destroying it. The work of removing a two or three year old larva is, of course, much more laborious than that of getting rid of the younger ones located nearer the surface. And, moreover, their presence in the tree is less readily detected. Orchards which have been carefully gone over twice during each season, from the time of planting, will contain few, if any, larva of the second or third season's growth.

Carbon bi-sulfid is recommended by some for the destruction of borers in the tree. A small amount of this substance is inserted into the tunnel of the borer and the hole stopped up with moist earth, or, better, with grafting wax. This method, while effective, and, if used judiciously, not harmful to the tree, does not seem to the writer practicable. At all events it is not a remedy to be recommended without qualification. Carbon bi-sulfid is somewhat expensive, and exceedingly explosive. It should be kept from flame and the fumes should not be breathed.

DAIRY FEEDING

The main source of income on fifty-one percent of Vermont's farms is derived from the sale of dairy products. It is the mainstay of from 27 to 33 percent of the farms in other New England states and New York, and of from 15 to 17 percent of those of New Jersey, Pennsylvania and Wisconsin. These data tell no new story; but they are an ample justification of the old-time policy of this Station which places dairy investigational work well to the front. Extensive feeding trials are an annual feature, trials designed to investigate methods of ex-

perimentation as well as to furnish data concerning food values; herd records are maintained and reviewed; and various minor matters are from time to time examined.

FEEDING TRIALS WITH COWS

The feeding experiments of the past winter were designed to aid in the answering of the following questions:

(a) What is the effect on the quantity and quality of milk and on the economy of production of a very low, of a low and of a medium grain ration? In times when grain feeds rule high may two pound grain rations prove economical?

(b) Can eight pounds of distillers' dried grains be fed daily with safety? Is it an economical practice, or are they better diluted?

(c) What are the relative feeding values of the distillers' dried grains and the brewers' dried grains?

(d) What are the relative feeding values of distillers' dried grains and cottonseed and linseed meals?

(e) What are the relative feeding values of brewers' dried grains and cottonseed and linseed meals?

(f) Can apple pomace be fed liberally with safety? Does increased profit parallel its increased use?

(g) What is the feeding value of pumpkins?

(h) What is the feeding value of distillers' dried rye grains?

(i) Is "Nutrene" a desirable addition to the list of dairy feeding stuffs?

(k) What is the extent of experimental error in feeding trials?

I. IS TWO POUNDS OF GRAIN FED DAILY ENOUGH?

The question as to the best amount of grain to feed a cow, viewed from the standpoint of profit as well as from that of the animals continued well being and usefulness, has been in review at this Station for four years. The results of the inquiry have been published in former reports.[1] Different rations have been fed which carried 4, 8 and 12 pounds of grain fed daily. The outcome—speaking broadly— has not favored the heavier ration, which, when the home-grown roughages were freely used, was always fed at a financial loss. The low, four pounds, ration, however, if looked at simply from the viewpoint of dollars and cents, quite often proved superior to the medium eight pound feed. In other words, when early cut hay, containing considerable clover, and well matured, well eared corn silage were fed in fairly liberal quantities, the extra milk, butter, and manurial value,

produced by feeding eight pounds of grain a day instead of four, was at times insufficient to pay the extra cost of the grain. When it did meet this cost, it seldom exceeded it to any extent. It is felt, however, that when the continued usefulness of the cow as a milk maker is considered that a somewhat more liberal grain ration than a four-pound one affords is generally to be preferred, particularly if the roughages are inferior in quality or lacking in quantity. However, the four-pound grain ration has certainly proved very satisfactory in several trials; and the question arises whether or not the limit has been reached. If four pounds has proved a fairly satisfactory ration to use, might not three pounds do about as well? And how about a two-pound ration?

The high prices lately ruling for grain have forced many dairymen to curtail their purchases. These heavy charges have also, and most fortunately, impelled many to study the relative values of the different grain feeds, and to make wiser purchases than hitherto. And they have made it more imperative than ever before that, if practicable and possible, the question of the lowest limit of the profitable use of grain feed for cows be determined. Prominent dairymen engaged in institute work, men who have made a success in their calling, are preaching the doctrine—and practicing it—of a two-pound or less daily grain ration for cows, claiming that so long as prices ruled high, they did not get a dollar back for a dollar expended on a larger amount of grain.

It seems to the writer in view of these conditions that it is well worth while to try and accumulate data which will contribute to the rational solution of this question. It is thoroughly appreciated that no one trial can settle it; that the character, quality and quantity of the roughages used, and the individuality of the cows, as well as that of the feeder, enter into the problem; that, in short, circumstances so markedly alter cases that the outcome of these trials or, if confirmed by further tests, of several trials would not be necessarily duplicated elsewhere by other feeders. The results of these trials then simply afford so much testimony as to the advisability of feeding very low grain rations, testimony which may or may not be confirmed by other witnesses.

The outcome of these trials summarized from the standpoint of product rather than of feeding may be stated as follows:

Quantity.—The more grain, the more milk, total solids and fat. The gains averaged 10 percent when the 4 pound ration replaced the 2 pounds feed, and about 18 percent when the 8 pound one was used.

In these trials a slight lowering of the quality of the milk accompanied the use of a very low grain ration.

Economy of production.—A pound of dry matter made more milk, solids and fat on the very low ration than on the medium. As between the low and the very low rations the outcome was nearly equal.

Live weight.—About two-thirds of the cows responded to radical changes in the amount of grain fed by gaining flesh or losing it, according as feed was added or withdrawn. Those uniformly fed as a rule held their own.

The salient points of the tables appearing in the main report and of the discussion appear below. The table shows the days of feeding on each ration, the added cost for feed of the higher grade ration, the net gain from butter sales, the net loss when these alone are considered as an asset, the value of the skimmilk and of two-thirds of the manurial ingredients, the net gain from butter, skimmilk and manure and the net gain or loss from feeding one cow for one day.

RELATIVE VALUE OF VERY LOW, LOW, AND MEDIUM FEEDING

	Low better than very low	Medium better than very low
Days of feeding on each ration	184	161
Cost of added grain feed	$3.32	$8.40
Net gain from butter sales @ 20 cents	$3.74	$6.42
Net gain or loss, i. e. cost of additional grain less value of butter	$0.42	—$1.98
Value of skimmilk and of two-third of the manurial ingredients	$2.03	$4.88
Net gain from butter, skimmilk and manure	$2.45	$2.90
Net gain from one day's feeding of one cow	1.33 cents	1.80 cents

Does it pay to feed as little as 2 pounds of grain daily?—When 2 pounds of grain were fed instead of 4, $3.32 were saved on grain bills and $3.74 lost in butter not made; when 2 pounds of grain were fed instead of 8, $8.40 were saved on grain bills and $6.42 lost in butter not made.

Since a 4 pound grain ration paid better than a 2 pound one when the butter increase alone is considered, so much the better does it appear when skimmilk and manurial constituents are taken into account. Since the 8 pound ration came within $2.00 of meeting extra grain bills by extra butter yield, and its skimmilk and manurial values exceeded those of the very low ration by nearly $5.00, the heavier ration may justly be counted the more satisfactory.

No one could see Atalanta, before and after taking, in good flesh December 5, but lean and gaunt May 27 after twenty-five weeks of

feeding on 2 pounds daily of grain, hay and immature silage; or view the sharp falls in milk yields which almost invariably followed the curtailment in the grain rations, or the partial increase which paralleled their restoral, without becoming convinced of the relationship between grain and milk. And the figures, which in this case maintain their proverbial honesty, tell the story of lessened profit.

The bulk of the records were attained with bran and brewers' grains, each selling below $20. When the distillers' grains, selling at $28, were used, less positive results were attained but they were in the same direction. Their number, however, were small because of reasons hitherto cited.

It seems fair to conclude that in these trials the restriction of the grain ration to 2 pounds was made at the expense of the animals' well-being and of the owner's pocket-book.

As to the relative merits of 4 and 8 pound grain rations, and the "best" grain ration as to quality and quantity the reader is referred to the last (15th) report, pages 299-300, and to bulletin 81.

II. DISTILLERS' DRIED GRAINS, CLEAR AND DILUTED WITH BRAN

About a year ago, however, several new brands of distillers' dried grains were offered in Vermont under their proper titles. They differed somewhat physically, though but little chemically, from the "Atlas" goods. They were new here and quite unlike anything hitherto offered. Inquiries began to come in as to their feeding values, also as to the amounts that it was safe to feed. There seemed to be room for further trials of these materials and several were planned.

These grains are the by-product of the manufacture of alcohol, spirits and whiskey from several cereals. They are simply the kiln-dried residues from the stills. They contain no alcohol, but, because of the fermentation which they have undergone, they have a peculiar and characteristic odor, which, however, is not at all disagreeable. There are quite generally three grades made, one from the distillation of alcohol and spirits, a second from the distillation of bourbon whiskey, and a third from that of rye whiskey. The first named is the higher in feeding value, and is most apt to be of even quality, corn being the main, and, sometimes, the only grain used. The other grades vary in their composition in proportion to the relative proportion of corn, rye and malt used in the mashes; the more the corn and the less the smaller grains, the better the grade of the product. The higher grades only have thus far been found upon the Vermont markets,

mostly guaranteed from 33 to 35 percent protein and 11 to 15 percent fat.

The Commissioner of internal revenue states that over twenty-three million bushels of grain—mostly corn—were used in the United States distilleries for the year ending June 30, 1900. The present annual output of distillers' dried grains exceed 40,000 tons, the larger share being exported to Germany for cattle feeding.

In one trial the clear undiluted grains were fed against a mixture of two-thirds grains and one-third bran; in another, against brewers' dried grains, and in a third against the old time cottonseed-linseed mixture (No. 1).

In this particular feeding trial the effect of heavy feeding was reviewed, inasmuch as sellers were stating that, owing to their flaky character, the goods did not need dilution with bran and might be fed clear with safety and with profit.

The general outcome was:

1. There was 3 percent less milk made on undiluted grains than on those diluted with bran.

2. No change in the quality of milk ensued.

3. The clear grains were not eaten as freely as when they were diluted with bran. More milk and butter to the unit of dry matter was therefore made when the clear grains were fed.

The grains cost more than the bran, but when fed clear they were eaten with less readiness. Hence the cost of the two rations was essentially the same. They carried also almost identical plant food values. Differences, then, were purely those of milk and butter yields. The diluted rations made a profit of 80 cents over its competitor, and a net profit of 69 cents, equivalent to three-quarters of a cent a day, practically all in the form of butter.

Every cow left more or less when fed the undiluted dried grains, averaging to eat but 7 of the 8 pounds fed. When they were diluted with one-third bran they were eaten without waste three times out of four. Not only was there waste but also a lessened milk yield when the grains alone were fed. Hence it seems fair to say that the results afforded by this particular trial does not favor the exclusive use of distillers' dried grains as a concentrate.

III. BREWERS' AND DISTILLERS' DRIED GRANS

The brewers' grains resemble in a general way the distillers' by-products. Like them they are kiln-dried residues from the manufacture of alcoholic beverages. They carry, however, less protein, more

carbohydrates, presumedly more modified starch, are made from barley rather than from corn and, often, contain a considerable proportion of malt sprouts.

Dried brewers' grains have been on the market as recognized feeding stuffs for many years. They have been fed both wet and dry. Their proneness to fermentation and putrefaction when wet have caused some to look askance at them, even when they are dried. Indeed, a prominent writer of recent days, using a novelist's if not a poet's license, has helped to give this feeding stuff a bad name. When kiln-dried, however,—the feed, not the novelist,—it is thoroughly safe product, as stable as any other and preferable in many ways to several standard goods. It has been fed at this Station for two years with entire satisfaction. It has thus far entered the New England trade to but a small extent.

The general outcome of the feeding trials was:

1. The distillers' grains made 5 percent more milk and 8 percent more butter than did the brewers' grains.

2. They made a somewhat richer milk, the gain being 0.14 percent fat or 3 percent of the total fat.

3. They were a little less freely eaten—5 percent less dry matter being consumed therein—than were the brewers' grains; but there was more hay and silage eaten when the former was fed, so that the dry matter consumption was was closely evened up. Production per unit of matter, however, favored the distillers' products.

The increment in quality where distillers' grains were fed is interesting. It never failed to appear during the three years in which the so-called Atlas gluten meal (a distillers' grains) was fed at the Station, is noted here and is seen also in the competitive trials with the cotton-seed-linseed mixture. There is something about distillers' dried grains which tends very slightly to raise the fat percentage of milk.

FINANCIAL CONSIDERATIONS

The outcome from the viewpoint of profit is of interest in this connection. Brewers' grains were bought for $19, while the distillers' grains cost $28. This increase in cost was sufficient to turn the scales against the latter goods. Although their use was followed by increased milk and butter yields and by an added manurial value, equivalent, at the conventional figures, to $1.44, the ration cost $1.63 more than its competitor, thus entailing a net daily loss of a fifth of a cent per cow.

Hence the distillers' grains in this trial proved a better but more costly ingredient of the ration than did the brewers' grains. Both by-products, when kiln-dried, are desirable additions to the list of dairy feeds.

IV. DISTILLERS' DRIED GRAINS VS. COTTONSEED AND LINSEED MEALS

The mixture of two-thirds wheat bran, one-third cottonseed and one-third linseed meals, denominated No. 1, has been a standard of comparison at this Station for a long time. It is in many respects a good combination to feed with mature corn silage and early cut hay. When corn ears are lacking in the silage a small amount of cornmeal is a desirable addition to the mixture; or it may take the place of the linseed, as in our No. 7 mixture for this year, when, because of the unfavorable growing season, corn ears were few. The No. 1 mixture has enough of that eminently desirable and safe milk-making feed, wheat bran, to serve as a dilutent of the heavier meals and to lighten the ration. The cottonseed and linseed meals supply liberal amounts of protein, and the one offsets the other's effect on the hardness of the butter fat. Its traditional number—No. 1—held for years, is a well merited one, although, in the various competitive trials of past years, it has sometimes come out second best.

A comparison was made this past winter of the relative merits of the old standby and of distillers' grains and bran mixed in the proportion of two to one. The two rations afforded nearly equal amounts of protein, but the latter rather more digestible dry matter, the increase being entirely in crude fiber and fat.

The general outcome of the feeding trials was:

1. There was no more milk made on one ration than on the other. One percent more solids and 3 percent more fat, however, were made on No. 3 than were made when its competitor was fed.
2. There was a small increase in the fat percentage when the distillers' grains were fed, similar to that seen in previous trials of this class of material.
3. Yields per unit of dry matter were practically uniform.

FINANCIAL CONSIDERATIONS

The distillers' grains ration made no more milk but nearly 3 pounds more butter than its competitor. The value of this extra 3 pounds more butter, however, was lost in the extra cost of the ration.

The cottonseed-linseed ration carried 3 percent more plant food than did the distillers' grains ration; and hence led by the slight amount of 0.38 cents daily per cow. The results are tabulated on page 247.

V. BREWERS' GRAINS VS. COTTONSEED AND LINSEED MEAL

The dried brewers' grains in feed mixture No. 2 were pitted against the No. 1 combination, using five cows.

The general outcome of the feeding trials was:

1. The same amounts of milk, solids and fat were made on each ration.

2. No change in quality of milk followed ration changes.

3. The production per unit of dry matter eaten was the same with each ration.

A more even result could have been looked for had no change whatever occurred in the feeding.

FINANCIAL CONSIDERATIONS

The butter made when No. 1 ration was fed was worth 34 cents more than that made when No. 2 was used. No. 1 was the richer of the two in plant food; but it was the costlier one by over two dollars. Hence the net result was against it to the extent of 0.46 cents daily.

VI. THE FEEDING VALUE OF PUMPKINS

The result of a brief trial of the relative feeding values of pumpkins and silage was outlined in the fourteenth report of this Station (pages 362-361). A second trial was carried out during the past winter, hay and pomace, however, being the alternates of the pumpkins.

The general outcome of the trial was:

1. Six percent more milk, solids and fat were made when the pumpkins were fed than when they were omitted from the ration. And, since there was 5 percent less dry matter consumed at the same time, the product to the unit thereof was bettered 10 percent.

2. The quality of milk was uniform on both rations.

In the experiment reported two years ago the pumpkin ration made as much milk as a silage ration. and 5 percent more proportional to dry matter consumption. In this test it decidedly surpassed the hay and pomace diet. The cows seemed in no way harmed by the pumpkin feeding, nor was the butter the worse for it.

FINANCIAL CONSIDERATIONS

There seems to be no good basis for estimating the money value of the pumpkins in attempting to measure financial results unless the same figure hitherto used for silage, soiling crops and the like be

used, i. e. $3.00 a ton. This, however, seems too high a price to allot to so watery a product. Yet on the other hand, $2.00 a ton seems a small price to compensate one for growing the crop. Using this sum, however, for the purpose of comparison, it is seen that the pumpkin ration cost $1.38 in excess of the other, an amount more than enough to offset the decided gain. At $1.90 a ton the account would just balance, without gain or loss on either side. In the former experiment 2½ pounds were judged to be nearly an equivalent in feeding value to a pound of silage. In this test 3300 pounds with 700 pounds of silage took the place of 500 pounds of hay and 900 pounds of pomace. Allowing equal weights of corn silage and of pomace silage roughly to offset each other, and bearing in mind the decidedly better yields obtained on the pumpkin ration, it seems fair to say that the equivalence of the pumpkins to the hay in these trials was about in the proportion of 6½ to 1.

Pumpkins at best can serve only as a fall or early winter feed. In spite of the good showing made it is doubtful whether as much dry matter or as cheap dry matter can be grown in pumpkins as is produced in the corn crop.

VII. NUTRENE

"Nutrene dairy feed" was offered in New England markets some thing over a year ago by Wogan Bros., of New Orleans. It was said to be a sugar-house by-product combined with wheat, corn and oat products. A sample critically examined by the Massachusetts Station was found to contain "molasses, absorbed by oat clippings or similar material, together with cottonseed hulls, some corn and a little cottonseed meal." The lot used in the feeding trial about to be discussed appeared to be of much the same general character.

Five cows were scheduled for use in a comparison of this material with the standard No. 1 (wheat bran, cottonseed and linseed meals) mixture. Four of the five struck. Three others were put in their places, and they, like their mates, protested. Powella, a farrow grade Jersey, making but 8 pounds of milk a day, ate her 8 pounds ration of Nutrene daily for six months and entirely without cavil. She held up her milk flow—what there was of it—save in the third period, giving as much in April and May as she did in December and January. Since her feeding was continuous, no comparison was possible. It was stated in the Massachusetts bulletin hitherto cited, that while "no exact experiments to determine the feeding value" were made, "it was fed to several cows with fairly satisfactory results," an outcome quite contrary to that obtained with our usually hearty eating cows.

"Nutrene" generally analyzes low in protein as compared with the rich concentrates which abound in New England markets. Two of the seven samples collected during the spring of 1902 carried over 23 percent, the remainder 17 to 18.5 percents. Samples analyzed at the Massachusetts station showed 14 and 16 percents. That used in the feeding experiment carried a little under 17 percent, which was its guaranty. It is evidently not calculated to narrow a ration.

Molasses is a good food for both man and beast. It is likely that it will be more largely used in cattle feeding in the future than in the past. Whether or not it will pay to freight low grade absorbents of molasses nearly 2,000 miles will depend on selling prices. Nutrene was bought at $23. Had it been readily eaten and proved a good milk maker, it might have been worth buying at that price.

VIII. HEAVY FEEDING WITH APPLE POMACE SILAGE

Two years' trials, the results of which have hitherto been discussed both in report and bulletin,[1] have amply proved that ensiled apple pomace has nearly the value of corn silage as a feed for dairy cows, when fed in moderate quantities, say 15 pounds a day. It was not so certain that it could be fed either with profit or with safety in large quantities. Hence several cows with good appetites were chosen, to which from 24 to 35 pounds of pomace silage a day were fed, while on that ration, and equivalent amounts of corn silage when on that feed. Several of these cows were originally scheduled to be fed "Nutrene" but they declined to accommodate themselves readily to such scheduling, and they ultimately found refuge in pomace silage and No. 7 feed.

The general outcome of the feeding trials was:

1. There was from 3 to 5 percent less milk and butter made when the corn silage replaced the pomace silage.

2. There was no essential difference in the quality of the milk made on the two rations. What little difference existed was in favor of the pomace ration.

3. Practically the same production to the unit of dry matter was made on each ration.

The poor quality of the 1902 corn silage previously alluded to was, undoubtedly, a factor in this result.

FINANCIAL CONSIDERATIONS

In the 1902 trials with seven cows the corn silage ration produced butter, skimmilk and plant food in excess of that supplied by the

pomace ration to the value of $1.28. But it cost $2.93 more. The use of the pomace saved a cent a day per cow.

The financial outcome of the present year is shown below. It is assumed, as hitherto and for the purpose of comparison, that apple pomace costs at the farm one dollar a ton. This sum would probably pay for the hauling and ensiling, but would not permit much to be paid for it at the mill.

The pomace silage ration fed 276 days made 3 percent more milk and 5 percent more butter than did its competitor fed for the same length of time. It cost, moreover, $7.83 less. The extra butter it made was worth $2.84 and the extra skimmilk about 25 cents. Its plant food content, however, was less than that of the corn silage ration. Its total extra production,—$2.09—plus its lessened cost—$7.83—make a total gain of $9.43, or nearly three and a half cents a day. If plant food and skimmilk are not held to be assets, and butter only is counted, the relative gain is even greater, $2.84+$7.83=$10.67 ÷276=3.87 cents daily gain.

In the present trials pomace silage outranked corn silage, even if the full money valuation of the latter—three dollars a ton—be applied to it. The two rations would then have cost within five cents of each other and the extra production of the pomace ration, worth $2.09, would have been equivalent to a gain of three-fourths of a cent daily.

This phenomenal result seems to be due to two things: to the inherent value of apple pomace as a food for cows, and to the poor quality of the immature corn silage. The outcome is strong testimony to the value of this product and indicates that the more is fed (up to the limit of healthful production), the more the profit.

The money value of apple pomace may be figured out in another way. The values allotted to the butter, to skimmilk and to two-thirds of the fertilizing ingredients in the experimental feeds, pomace and silage, were $75.09 and $73.57 respectively. Subtracting from these sums the estimated costs of the hay and grain, $38.53 and $38.60, leaves as sums which may be used for purposes of comparison $36.51 and $34.97. The amounts of corn and of pomace silages fed were 7505 and 7387 pounds respectively. A small amount of corn silage (101 pounds) was fed during the pomace periods, but this was so small an amount that its effect may be ignored without endangering the accuracy of the deductions.

A fair comparative—but by no means an absolute—showing may be made by proportion:

7505 : 2000 :: 34.97 : x = 9.33.
7387 : 2000 :: 36.51 : x = 9.88.
9.33 : 9.88 :: 100 : x = 106.

If the reasoning on which this calculation is based is correct the feeding value of the pomace eaten this year is as great as or greater than that of the silage. In last year's trials the relation thus figured out was 100 : 100 and in the previous year's trial, 100 : 84. The corn silages, however, were far superior both years to that fed during the past winter.

In whatever way the matter is figured out, pomace at a dollar a ton at the barn is a bargain, and at a considerably higher sum is a fair equivalent of corn silage. The four years of trials at this Station lead it to urge farmers to use it freely. It should be fed lightly at first, however, until the cows get accustomed to it, then as high as 35 pounds daily may often be fed without harming the cow or depleting the pocket book.

RECORD OF THE STATION HERD FOR 1902-1903

The doings of the Station herd for the past year (Nov. 1, 1902 to Oct. 31, 1903) appear here, partly as a matter of record for future reference and partly because of the good effect which its perusal may exert on dairymen. It is hoped at the end of the next record year, when a decade of data taking will have been completed, some collection and digestion of the accumulated mass of figures may be made.

The current year's record is the poorest one made since the establishment of the Station herd. There are several reasons for this outcome.

1. The extreme drought of the spring of 1903 and the short pasture resulting therefrom.

2. The immature silage due to the wet summer of 1902.

3. The use of nearly a third of the cows in feeding trials which involved very light grain feeding—2 to 4 pounds daily.

In no case were the cows forced, and as has been remarked, they were often underfed. It is no wonder that the record is a low one.

The records shown on the next few pages include for each cow the production of milk, total solids, fat and butter, the cost of the food eaten to the 100 pounds of milk and to the pound of fat and butter, the total cost of the food eaten, of the purchased grain, the net proceeds from butter sales—at the average price actually received during

the year for butter—and the value of the fertilizing ingredients in the fodders and feed eaten.

The average production of milk and of butter for the entire herd during the last eleven years has been satisfactory and fairly uniform. The butter productions have been as follows: 1892, 335 pounds; 1893, 330 pounds; 1894, no record; 1895, 325 pounds; 1896, 324 pounds; 1897, 338 pounds; 1898, 315 pounds; 1899, 320 pounds; 1900, 357 pounds; 1901, 343 pounds; 1902, 308 pounds; 1903, 294 pounds. The herd of 1892-93 contained about twenty cows and was slaughtered early in 1894 because of tuberculosis. The animals included in the present herd were bought at various times, from 1894 to 1903.

There were 70 cows in the herd within the limits of the record year,[1] but only 48 were members throughout the year. Some of the cows not figuring in the main tabulations were heifers with their first calves; some were sold for beef and some were purchased during the year. The records of the cows which did not finish their record year have been kept as carefully as have those of the animals which completed the year. These broken records have not the value that pertains to complete data, yet, inasmuch as several of these cows figured in past records and many of them will figure in future ones, it is thought best to publish the figures. They follow the main tabulations. The cows whose names are italicized in the tables are registered Ayrshires, those in black face are registered Jerseys. All others are high grade Jerseys. Most of the animals have higher records in past years than those given in the present tabulations.

The remarks on this page and four pages further on are explanatory of the record tables on the next four pages.

"*Pounds of milk*" are obtained by weighing each milking of each cow throughout the year.

"*Percent of fat*" is obtained by averaging by cross-division. Composite samples—eight or nine milkings each—are taken of the milk of each cow bi-monthly throughout the year and constantly while on feeding experiment.

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[1] Nov. 1 to Oct. 31 constitutes a record year.

RECORD OF THE HERD OF THE VERMONT AGRICULTURAL EXPERIMENT STATION FOR THE YEAR FROM NOV. 1, 1902, TO OCT. 31, 1903

Name of Cow	Calved	Served	Days in milk	Milk	Total solids	Fat	Total solids	Fat	Butter
				lbs.	%	%	lbs.	lbs.	lbs.
Acme 5th, 10342 A. R.	March 25	Jan. 3	250	4221	11.90	3.75	502.4	158.5	184.9
Adelaide	April 13	Dec. 16	254	5363	13.98	4.88	749.8	261.6	305.2
Atalanta, 10777 A. R.	Aug. 1	Feb. 7	327	5519	12.32	3.68	679.9	203.0	236.8
BEAUTINA, 85928 A. J. C. C.	Feb. 11	Sept. 6	323	5286	13.98	4.84	732.1	253.3	295.5
Ceres	Jan. 6	March 20	314	5888	14.67	5.24	862.8	308.5	359.9
Dahlia	May 13	Aug. 1	365	4349	15.17	5.70	659.9	247.8	289.1
Dorothy	Feb. 14	July 4	311	4884	14.50	4.98	635.7	218.3	254.7
Edith	Jan. 25	July 19	323	6527	14.10	4.96	920.5	323.7	377.6
Elsa	.....	Nov. 30	321	5273	14.31	5.11	754.5	269.4	314.3
Eunice	Dec. 3	March 11	327	6330	14.18	4.80	896.3	303.4	354.0
Eva	Jan. 1	Sept. 2	333	4324	16.34	6.41	706.6	277.2	323.4
Flora	July 29	Dec. 27	268	4122	13.97	4.86	575.8	195.2	227.7
Fresno	Dec. 2	Feb. 6	272	2468	14.33	4.82	353.7	118.9	138.7
Goldenrod	July 31	March 24	329	4413	16.90	6.71	745.9	296.3	345.7
Haidee	.....	.....	303	5498	14.92	5.34	820.0	293.4	342.3
Hallowe'en	April 30	March 14	365	4076	15.08	5.65	614.5	230.3	268.7
Inez	Nov. 23	May 4	334	5642	14.92	5.54	841.9	312.4	364.5
Janice	.....	Jan. 10	365	4448	14.97	5.20	665.9	231.2	269.7
Jersey Lily 2nd	.....	.....	280	3958	15.62	5.86	618.4	231.8	270.4
Juanita	Aug. —	Oct. 29	317	4495	15.44	5.66	694.1	254.2	296.6
Kimberley	Feb. 6	April 12	310	4625	18.07	4.05	604.2	187.5	218.8
LADY PERUSIA, 123228 A. J. C. C.	Nov. 23	May 4	340	6188	15.20	5.78	941.0	357.5	417.1
Lavender	Farrow	Oct. 26	271	3434	14.96	5.60	513.6	192.2	224.2
Lorna Doone	Feb. 24	Nov. 18	249	3099	13.38	4.20	414.5	130.3	152.0
Lucerne	Oct. 11	Jan. 31	309	4680	15.26	5.61	714.2	262.4	306.1
Maid Marian	July 2	March 21	365	5084	14.04	4.87	713.9	247.7	289.0
MAX BELLE, 108996 A. J. C. C.	Nov. 4	July 7	357	5548	15.23	5.50	845.0	305.3	356.2
Max Ella	.....	.....	325	4129	14.17	4.82	586.0	199.1	232.3
Mermaid	Feb. 11	Sept. 4	304	4571	16.16	6.30	738.7	288.2	336.2
MINTA BELLA, 85578 A. J. C. C.	June 7	Aug. 3	321	6200	15.08	5.66	934.8	351.0	409.5
Mona	*June 7	April 16	290	2991	14.79	5.40	442.6	161.4	188.3
Nancy B., 9581 A. R.	April 24	Oct. 25	317	5610	12.61	3.81	707.5	213.8	249.4
Orpha	April 16	Oct. 21	307	5866	13.49	4.24	791.1	248.8	290.3
Pomona	Dec. 9	March 16	325	4705	15.11	5.46	711.0	256.8	299.6
Primrose	Jan. 7	.....	303	4584	13.65	4.61	625.9	211.5	246.7
Rosel	June 7	Nov. 19	327	6129	14.48	4.98	899.0	305.6	356.5
Rosemary	Jan. 4	April 4	256	4661	13.96	4.66	650.7	217.0	253.2
Santa Clara	May 16	Oct. 20	247	5382	15.71	5.85	845.7	315.0	367.5
Santa Rosa	July 16	Nov. 6	327	5368	14.23	4.64	694.8	226.4	264.1
Serena	Nov. 20	May 9	344	6221	14.13	4.77	879.0	297.0	346.5
Sonoma	Jan. 10	April 5	335	6081	14.68	5.16	892.8	313.6	365.9
Star Bright	*Sept. 21	July 6	365	5156	15.68	5.88	808.7	303.2	353.7
Stella	Nov. 28	March 14	296	5988	14.14	4.70	839.6	279.0	325.5
Surprise	June 13	Feb. 18	309	3538	15.02	5.31	530.8	187.6	218.9
VERMONT UNA	Dec. 12	Aug. 3	310	4489	15.16	5.69	680.2	255.3	297.9
Ursula	Aug. —	Dec. 2	324	5821	14.92	5.27	863.2	306.9	358.1
Vivian	.....	Nov. 16	350	5358	13.90	4.63	745.0	247.9	289.2
Yuba	July 29	Jan. 14	297	4194	15.25	5.58	639.5	233.9	272.9
Averages				4920		5.18	714.2	251.8	293.8

HERD RECORD—Continued

Name of Cow	Total cost of food	Total cost of purchased grain	Cost of food for 100 pounds of milk	Cost of food for 1 pound of fat	Cost of food for 1 pound of butter	Proceeds from butter sales at 30 cents per pound	Value of fertilizing ingredients
	$	$	cts.	cts.	cts.	$	$
Acme 5th	48.24	20.31	114.3	30.4	26.1	55.47	28.60
Adelaide	50.75	18.21	94.6	19.4	16.6	91.55	30.27
Atalanta	43.41	14.34	78.6	21.4	18.3	71.04	24.81
Beautina	54.04	27.18	108.2	21.3	18.3	88.64	31.64
Ceres	51.33	22.45	87.2	16.6	14.3	107.97	30.34
Dahlia	56.84	28.47	130.7	22.9	19.7	86.72	33.76
Dorothy	51.09	22.18	116.5	23.4	20.1	76.41	31.05
Edith	54.06	24.38	82.8	16.7	14.3	113.27	32.55
Elsa	45.72	13.11	86.7	17.0	14.5	94.29	27.01
Eunice	52.81	20.88	83.6	17.4	14.9	106.20	30.61
Eva	48.62	23.26	112.4	17.5	15.0	97.02	29.96
Flora	39.45	12.68	95.7	20.2	17.3	68.31	23.25
Fresno	37.99	9.49	153.9	32.0	27.4	41.61	21.03
Goldenrod	61.21	28.56	138.7	20.7	17.7	103.70	37.11
Haidee	57.41	25.15	104.4	19.6	16.8	102.68	34.48
Hallowe'en	58.99	27.24	144.7	25.6	22.0	80.60	34.79
Inez	48.10	16.08	85.2	15.4	13.2	109.33	26.98
Janice	55.87	27.18	125.6	24.2	20.7	80.90	33.11
Jersey Lily 2nd	47.84	19.03	120.9	20.6	17.7	81.12	27.99
Juanita	51.07	23.29	113.6	20.1	17.2	88.97	30.50
Kimberley	51.63	21.52	111.6	27.5	23.6	65.64	30.81
Lady Perusia	51.51	19.43	83.2	14.4	12.4	125.12	29.40
Lavender	47.39	21.70	138.0	24.7	21.1	67.26	28.54
Lorna Doone	38.10	15.68	122.9	29.2	25.1	45.60	22.20
Lucerne	44.19	16.31	94.4	16.8	14.4	91.82	25.78
Maid Marian	43.01	17.82	84.6	17.4	14.9	86.70	23.89
Max Belle	57.86	26.75	104.3	19.0	16.2	106.85	34.71
Max Ella	52.51	23.75	127.2	26.4	22.6	69.68	31.29
Mermaid	49.12	24.21	107.5	17.0	14.6	100.86	30.04
Minta Bella	52.13	23.66	84.1	14.9	12.7	122.83	30.93
Mona	49.68	24.54	165.9	30.8	26.4	56.49	29.40
Nancy B	53.24	25.73	94.9	24.9	21.3	74.82	31.13
Orpha	55.80	24.23	95.1	22.4	19.2	87.08	32.28
Pomona	48.45	18.41	103.0	18.9	16.2	89.87	28.39
Primrose	55.89	24.27	121.9	26.4	22.7	74.00	33.59
Rosel	57.96	26.64	94.6	19.0	16.3	106.93	35.09
Rosemary	49.68	20.01	106.5	22.9	19.6	75.96	30.25
Santa Clara	51.41	25.19	95.5	16.3	14.0	110.23	32.45
Santa Rosa	50.56	23.16	103.5	22.3	19.1	79.22	29.90
Serena	60.29	29.86	96.9	20.3	17.4	103.94	35.56
Sonoma	56.62	26.72	98.1	18.1	15.5	109.76	33.41
Star Bright	58.25	28.39	113.0	19.2	16.5	106.10	35.30
Stella	56.24	25.34	94.7	20.2	17.3	97.64	32.62
Surprise	39.39	17.22	111.5	21.0	18.0	65.66	21.95
Vermont Una	44.57	19.42	99.3	17.5	15.0	89.36	25.70
Ursula	55.72	23.93	95.7	18.2	15.6	107.41	34.26
Vivian	54.58	27.14	101.9	22.0	18.9	86.75	32.58
Yuba	47.57	22.37	118.4	20.8	17.4	81.86	28.68
Averages	51.00	22.22	106.9	21.1	18.0	88.15	30.23

"*Pounds of butter*" are obtained by adding the usual factor *one-sixth* to the pounds of fat. This is equivalent to a "surplus" of 16.7 percent. The conditions of our work (much sampling, varying methods of handling, frequent handling of relatively small quantities, etc.) are such that it is doubtful whether our average "surplus" is often thus high. Much cream and some milk are sold, and large amounts are taken as samples; hence our exact make *all as butter* cannot be stated. Conservative estimates of the butter values of these sold and sampled products, added to the known butter sales, when compared with calculations using the one-sixth factor, have in years past agreed within a narrow margin and show a surplus of 12 to 14 percent. It is manifestly unfair to charge against the cows these losses, which are to a considerable extent caused by the peculiar nature of our work and which do not obtain in ordinary dairy management.

"*Cost of food*" is reckoned from prices paid for grain, while hay is rated at $10, silage, soiling crops, etc., at $3, pasturage for the season at $5 per animal.

The average cost of food for 100 pounds of milk and for a pound of butter as stated in the table is obtained by dividing the total by 48, thus giving each cow the same value in the average, be her record good, bad or indifferent. *As a herd* the average cost of food for 100 pounds of *herd* milk and for a pound of butter were considerably less than is stated.

The figures showing "cost of 100 pounds of milk" and "cost of one pound of butter" include only the cost of food as laid down in barn ready for feeding. They do not include cost of feeding, caring for cows, making and marketing butter, depreciation of plant, interest on investment, etc. It is to be remarked, however, on the other hand, that many items other than those cited may be considered, in some degree at least, an offset against these expenditures and charges. Thus for example, it should be noted:

1. That "roughages" are rated as figures sufficiently liberal to more than cover the cost of raising and harvesting in average seasons.

2. That the manurial constituents in the food fed at the barn are worth nearly half of its rated cost if these are reckoned at market prices for the same plant food of nearly if not quite the same availability in the form of commercial fertilizers. There are also considerable amounts of plant food in the pasture grass eaten and thus transferred to the barn, not included in the schedule.

3. That the manurial constituents in the purchased grain were worth, when similarly rated, about three-fifths of its market price.

4. That a ton of butter removes less than a half dollar's worth of plant food from the farm.

5. That the increase of the herd and the sales of calves and fat cows are further items not considered above.

6. That the skimmilk and buttermilk from the 48 cows, at 20 cents per hundred (an absurdly low price as pork sells to-day), was worth in the vicinity of $450.00.

The herd on the whole made the most butter in 1899-1900, and made it most cheaply in 1895-96. Yet owing to the selling prices for butter, the financial showing of the past four years is better than that of former years. These points are brought out in the following table:

Year	No. of cows	Pounds of milk	Pounds of butter	Cost of feed	Proceeds for butter	Value of butter over cost for feed
1903	48	4910	294	$51.00	$88.15	$37.15
1902	49	5166	308	49.13	85.33	36.20
1901	47	5814	344	49.97	94.56	44.59
1900	45	5935	357	52.43	97.15	44.72
1899	47	5462	320	45.17	83.18	38.01
1898	42	5296	313	46.40	80.58	34.18
1897	29	5730	338	47.45	82.04	34.59
1896	37	5431	324	42.00	74.51	32.51
1895	33	5633	325	50.06	76.40	26.34

The following tables show extremes of quantity, quality, cost of production, etc., during the year:

EXTREMES OF PRODUCTION

	Lowest amount for any cow		Highest amount for any cow	
Pounds of milk	2468	Fresno	6527	Edith
Percent of total solids	11.90	Acme	16.90	Goldenrod
Percent of fat	3.68	Atalanta	6.71	"
Pounds of total solids	353.7	Fresno	941.0	Lady Perusia
Pounds of fat	118.9	"	357.5	"
Pounds of butter	138.7	"	417.1	"
Cost of feed	$37.99	"	$61.21	Goldenrod
Cost of grain	$9.49	"	$29.86	Serena
Cost of 100 pounds of milk	78.6¢	Atalanta	153.9¢	Fresno
Cost of 1 pound of fat	14.4¢	Lady Perusia	32.0¢	"
Cost of 1 pound of butter	12.4¢	"	27.4¢	"
Value of butter at actual selling price	$41.61	Fresno	$125.12	Lady Perusia
Value of fertilizing ingredients in food	$21.03	"	$87.11	Goldenrod

The usual wide extremes are found. The herd, as a whole, as had been already noted, did poorer work than at any time in ten years. Almost every cow fell off more or less and the average production of milk was lower than ever before.

It is interesting to note the reason for the record of the tail-ender, Fresno. This cow made 307 pounds of butter during her first record year in milk. She is of good breeding and of good dairy conformation. She was fed for twenty-five weeks during the past year

continuously a daily grain ration of but two pounds. During the entire year she ate less than ten dollars' worth of grain, but little more than 40 percent of what the average cow of the herd received, and but little more than a third of what the better-fed cows ate. She made 139 pounds of butter instead of 307. In her first year she ate $18.90 worth of grain, almost exactly double the cost of her 1903 grain ration; but she made more than twice as much butter. It cost—for food—27.4 cents a pound to make the butter one year, but 15.9 cents a pound the other year. The receipts for butter were $41.61 one year and $85.24 the other. She went dry quickly and stayed dry long; and who can blame her?

There are many Fresnos in New England dairies; cows which are capable of doing good work, but are given no chance. Not every cow which makes but little butter responds as Fresno does when well fed. Some are not built that way; but lots of them would do so. Give such cows a chance.

The following table shows the feeding record of each cow which was a member of the herd within the record year. All of the cows were out to pasture for about five and one-half months, but were housed over night. They were fed twice daily the year around, grained during the summer to some extent, watered in winter twice a day, and turned out in the winter for from 20 to 40 minutes daily except in extreme weather. The station herd is used in feeding experiments from December to June, during which time the cows are subjected to many changes in ration. In some cases materials may be fed which are distasteful, and, frequently, wasteful or ill-balanced rations are designedly used. These changes, necessitated by the conduct of feeding experiments, are obviously not conducive to maximum production. At no time was special effort made to select or to feed the most economical ration, or to force any cow to her utmost.

NAME	Hay	Silage	Apple pomace	Rowen*	Green hungarian	Wheat bran	Corn meal	Cottonseed meal	Linseed meal	Dried distillers' grains	Dried brewers' grains	Nutrene
Acme	3468	1696	1328	196		1292	329	298	13		23	12
Adelaide	4045	2681	1242	554	163	1175	387	174	13		23	12
Alta	484	2256		545	162	967	379	80	13		23	12
Atalanta	2696	6053	278	276	160	801	245	73	12	3	297	12
Beautina	2459	4575	275	560	164	1362	420	64	4	378	384	7
Bertha	2522	3598	277			562	44	44			776	
Buttercup	199		28			52	14	14				
Ceres	3496	3457	2419			1448	499	203	13		27	12
Clare	362		118			118	28	28				
Constance	523	1986		562	160	984	381	83	14	361	24	12
Dahlia	2586	5192	271	551	164	1578	396	188	99		22	12
Dorothy	3097	3705	1226	492	158	1350	367	161	93		192	12
Edith	3081	4278	678	560	155	1550	379	225	154		23	12
Eleanor	515	2255		557	163	984	374	83	14		24	12
Elsa	3231	6044	278	507	122	723	188	62	12	571	335	9
Eunice	2887	6585	128	559	163	942	283	88	12		22	11
Eva	2885	990	3837	557	164	1508	410	184	141			
Fairie	318		105			98	25	24				
Flora	2529	5130	278	314		632	98	71	11		481	11
Fresno	2820	6028	108	72		421	94	27	11	266	21	11
Goldenrod	3345	6099	278	336	163	1444	297	166	105	555	23	12
Haidee	3485	4435	1247	561	163	1608	450	209	129		23	12
Hallowe'en	3651	2524	1810	547	162	1759	557	298	13		23	12
Idarella	1186	1845	278			590	146	146				
Inez	2879	6681	98	561	164	884	326	28	12	234	22	11
Janice	2569	5450	276	553	162	1317	365	75	13	453	349	12
Jersey Lily 2nd	3159	3045	1781	561	162	1234	441	148	12		23	12
Juanita	2601	4761	266	548	162	1062	265	44		370	513	
Judith	495	2221		551	164	966	367	77	14		24	13
Katrina	1815	2960	224			376	82	31		2	501	
Kimberley	3269	3553	1794	556	163	1381	332	78	18	251	23	13
Lady Perusia	2906	6648	108	556	163	985	345	49	12	373	21	12
Lady Ullan	1058	2156	1213	542	163	1093	405	125	12		22	11
Lavender	2427	3940	278	549	164	1369	269	231	188			
Linnet	1201	2988		430	149	682	245	81		179	18	9
Lizzie Hexam	514	2247		555	162	1084	332	86	14		24	13
Lorna Doone	1985	3268	227	558	160	944	200	136	104		131	
Lucerne	2694	5807	278	122	40	851	207	74	13	3	506	12
Maid Marian	2782	2549	275	561	168	1011	322	72	12	5	366	10
Max Belle	2701	6625	258	557	163	1363	360	65	13	11	934	12
Max Ella	2960	4083	738	558	162	1510	417	220	111		23	12
Mermaid	2485	2647	1954	556	164	1533	354	232	188			
Minta Bella	2906	4178	278	556	163	1519	380	196	152		22	12
Mona	3557	1873	1324	72		1388	373	301	12		22	13
Monterey	2295	3560	273			408	44	44		840		
Muriel	1376	4216		443	127	890	255	110	79		17	194
Nancy B	3536	1661	1328	557	162	1507	489	272				
Naomi	2265	1744	1640			832	61	210	148	30		
Nora	405	711				180	45	45				
Orpha	3519	3975	278	563	164	1576	560	198	13		23	13
Pomona	2870	5425	168	543	158	964	275	21	13	11	602	13
Powella	2479	4394	277			172	44	44				1372
Pretoria	2543	4133	288			410	44	89	46	4	457	155
Primrose	3406	4583	548	539	159	1319	320	121	104	356	21	12
Queenie	916	2908		501	165	956	334	116	12		22	12
Rosel	3189	5135	278	553	163	1070	217	67	13	933	20	12
Rosemary	3399	4223	482	195	162	1241	202	215	197		23	13
Santa Clara	2399	3208	3753	554	161	1587	304	269	225			
Santa Rosa	2674	3747	1764	556	162	1395	442	239	15		18	134
Serena	2882	5619	114	558	161	1083	341	44	13	1065	23	13
Sonoma	3088	4647	354	565	155	1097	368	72	13	779	23	12
Star Bright	2749	5608	277	566	162	1597	371	168	106	10	564	12
Stella	2929	5747	108	267	162	520	199	33	12	1232	21	12
Stephanie	472	2161		557	163	1087	435	84	13		23	12
Surprise	2075	2897	228	514	147	1107	416	133	7		21	7
Sylvia	186		28			52	14	14				
Una	2390	3702	221	561	159	1234	356	153	100		22	12
Ursula	3228	5511	278	502	124	1168	254	75	12	10	942	12
Vivian	2514	4811	278	553	159	1134	257	61	15	902	17	9
Yemassee	369	2041		559	164	1010	415	64	13		22	13
Yuba	2705	3659	1836	63		1332	352	252	13	145	30	13

*Roughly 25 percent of rowen fed was green or partly dried; the remainder was rowen hay.

WHAT KIND OF CORN SHALL BE PLANTED FOR SILAGE?

The wet summers of 1902 and 1903 and the consequent immature corn crop have served better than any Experiment station test to deter farmers from further planting of varieties which will not mature in normal seasons; yet a brief account of trials made in 1900 and 1901, in the seasons before those in which "the rains descended and the floods came" may not be amiss, nor their moral lost.

Four varieties of corn, Sanford, Red Cob, Leaming and a dent corn from Virginia, much vaunted by an institute speaker in Vermont during the winter of 1899-1900, were planted each year.

Sanford corn is a relatively small flint corn, largely grown and favorably known throughout northern New England. Red Cob is a larger variety, which frequently will nearly and occasionally quite mature at Burlington. Leaming is a larger variety, popular in southern New England, characterized in particular by a highly developed leaf growth. The Virginia corn (variety unknown) was a large, impressive looking dent corn, for which great things were claimed as to its growth in latitudes south of 40°.

The larger corns produced from 50 to 70 percent more gross weight than did the Sanford, but only an average of 10 percent more dry matter, and that was less mature.

The several crops were ensiled. It was found impracticable to make exact separations in the silo, so that only general statements are possible. The silages were fed to many cows and the surface dropped rapidly, which tended to lessen loss. According to the records for 1900 the two dryer corns, Sanford and Red Cob, when ensiled, lost but 2 percent in total weight, while the wetter ones, Leaming and Virginia, lost 20 percent. The latter lost 14 percent of dry matter and the former seemed to gain a small amount of dry matter, an obvious impossibility. The dry matter loss, however, can confidently be stated to have been slight. Assuming 5 percent loss in the one case and 14 percent in the other, less dry matter was actually put into the cows' mangers from an area planted to the large varieties than was derived from an equal area planted to the smaller kinds. The comparison was not made with the crop of 1901.

The silages were fed in the course of the feeding trials of 1900-1901 and of 1901-1902. When cows were changed from Sanford silage to that derived from the larger corn, shrinkage in milk flow ensued if no increase was made in the weight of silage fed in order to offset its lessened feeding value.

A survey of the analyses of these silages as shown in the report, indicate that:

1. The dry matter of the Sanford corn tends to be a shade richer in protein, a good deal richer in the more desirable carbohydrates (starches, etc., fat) and less rich in its less desirable form (cellulose) than the other varieties. This no doubt is largely due to its greater maturity; that

2. Its dry matter carries less potash than that of its rivals, a good point in its favor; that

3. The dry matter of the Sanford silage was richer in protein, starch, etc., than were those of the immature corns.

The large corns look impressive, but they yield at best but little and often no more actual food matter than do some smaller varieties. One has the satisfaction of seeing immense growths, but gets no other return. The farmer has, moreover, to harvest and house large tonnages of water which may generally be procured cheaper in other ways.

HOW LONG MAY A FINISHED BABCOCK TEST BE PRESERVED UNIMPAIRED?

Four Babcock tests of milk, made by the writer in late September, 1900, at the Valley Fair grounds, Brattleboro, were used to determine the possibility of preserving them for great lengths of time. The bottles containing the acid liquid and supernatant fat were placed in a dark cupboard in the dairy building, where they remained for three years, through winter's cold and summer's heat, experiencing temperatures below zero and approximating 100° F. These bottles and their contents were inspected annually in late September, warmed to 120-130° F., whirled in a Babcock centrifugal for a minute or two, the fats reread, and their conditions noted. The tests were made on fresh, unpreserved milks, in a hand tester. The results are appended:

Year	Percent fat	Condition as regards clarity of fat	Conditions as regards curd
1900	5.15	Clear	One minute speck
1901	5.25	"	A little curd
1902	5.20	"	Some black curd below fat
1903	5.20	Somewhat cloudy	Much curd
1900	4.60	Clear	Very slight specks
1901	4.60	"	"
1902	4.50	"	Some curd
1903	4.70	Rather cloudy	Much curd
1900	4.80	Clear	Some curd
1901	4.80	"	"
1902	4.80	"	"
1903	lost		
1900	4.60	Clear	Slight specks
1901	4.60	"	Some curd
1902	4.40	"	Much more curd than others
1903	3.80 (?)	Very cloudy	Large amount of curd; pratically impossible to read

A year's keeping in the dark in heat and cold did not impair the reading. Two years did not materially affect the results save that there was considerable "curd" formed which partly obscured the readings. By the end of the third year their values were largely gone. During this year, however, the bottles had been moved to another building, and seemed to have absorbed some water.

These results are of interest as indicating the possibilities of preserving the actual analyzed material for future use in cases of dispute. It seems likely that a capped and sealed test-bottle, kept in the dark, in a cool place ought to present readable contents for a year, or, indeed, two years after the tests were made, unless perchance the preservative, if such were used, should have some ill-effect.